FURTHER ETHERNET ISSUES

- Types of Media
- Round Trip Time / Slot Time / Packet Sizes
- Performance at the “user/application” level
- Bridges / Switches.

CO-AX MEDIUM OPTIONS (IEEE 802.3)

- Original (10BASE5)
  - 10Mbps using baseband coaxial cable, segment length 500m, max. 100 taps per segment, max. 4 repeaters between any pair of stations.
- 10BASE2 (issued 1985)
  - thinner coaxial cable, segment length 185m, max. 30 taps per segment.

OTHER COMMON MEDIUM OPTIONS (IEEE 802.3)

- 10BASE-T (802.3i)
  - unshielded twisted pair, 10Mbps
- 100BASE-TX
  - 100 Mbit/sec via twisted pair.
- 1000BASE-T
  - gigabit Ethernet via twisted pair
- 10 Gbit/sec Ethernet
  - Only point-to-point, various media options
- Other “fibre” variants

SLOT TIME / MINIMUM PACKET SIZE

All stations attached to an Ethernet **<u>MUST</u>** become aware of all collisions involving packets that they send.

Worst case:

B starts to transmit just as ‘A’s packet reaches ‘B’ and corrupts it.

We need ‘A’ to STILL be involved in sending the same packet when the corruption propagates back down the network and reaches ‘A’.

Thus, packet length must be such that time to transmit is greater than twice the ‘transmission delay’ for the longest route in the network.

For 2.5Km network (maximum allowed), 10Mbit/sec, slot time is 51.2 micro seconds. This is equivalent to a 512 bit packet.

MAC FRAME FORMAT FOR 802.3 (ETHERNET)

Number of Octets	Field Usage
7	Preamble
1	Start of Frame Delimiter
6	Destination Address
6	Source Address
2	Length in 802.3 / packet type in original Ethernet
46 to 1500	Data + Padding
4	Frame Check Sequence

- Time for frame 51.2 micro seconds plus 6.4 micro seconds for preamble.
- Also 9.6 micro second interframe gap.

THROUGHPUT EXAMPLE

- Simple application like ‘vi’ editor using remote echo from remote host.
- Packets of minimum Ethernet size. 10Mbit/sec co-axial Ethernet

Time for progress (micro seconds)

Event	Time
IDLE	0
A starts preamble	0
A finishes preamble	6.4
A starts packet	6.4
A finishes packet	6.4+51.2=57.6
B receives last bit	57.6+25.6=83.2
B starts interframe gap	83.2
B reaches end of gap	83.2+9.6=92.8

- The time to transmit single character and receive echo is thus 185.6 micro seconds.
- Number of characters per second = 5387.9.
- “Raw” Ethernet speed = 10Mbit/sec = 1.25 Mbytes/sec but the application user only gets 5.4 Kbytes/sec !

PROBABILISTIC CHARACTERISTICS OF CSMA/CD

All access to the 802.3 LAN only completes with some probability. It is thus impossible to guarantee transfer rates. When the net is very busy collisions might go on forever !

Real Time Use

Debates often take place on the usability of CSMA/CD LANs for real time use. The answer depends on the true use intended rather than the LAN.

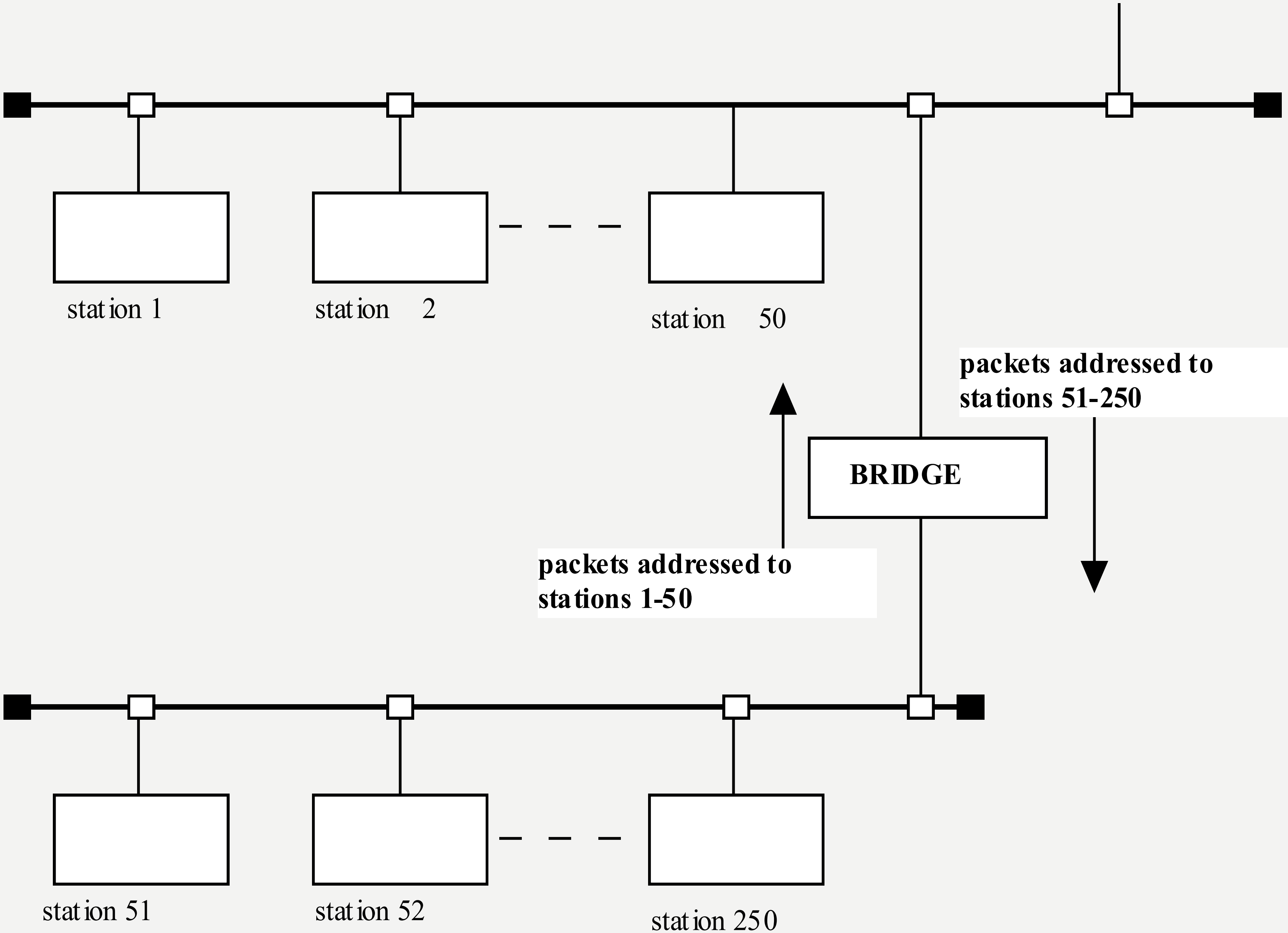
BRIDGES / SWITCHES

- Partition LAN to segregate load.
- Partition LAN to add reliability.
- Partition LAN to add security.
- Combine remote LAN segments into a single logical network.
- Combine separately developed and controlled LANs.

BRIDGES / SWITCHES

- IEEE 802 LANs often include bridges or switches
- Repeater cleans and forwards *all* data, basically forwards electrical information
- Bridge/switch selectively forwards data, stores and forwards complete packets
- Bridge/switch forwarding based on header information.
- Bridges/switches sometimes known as ‘MAC level relay’

BRIDGES / SWITCHES



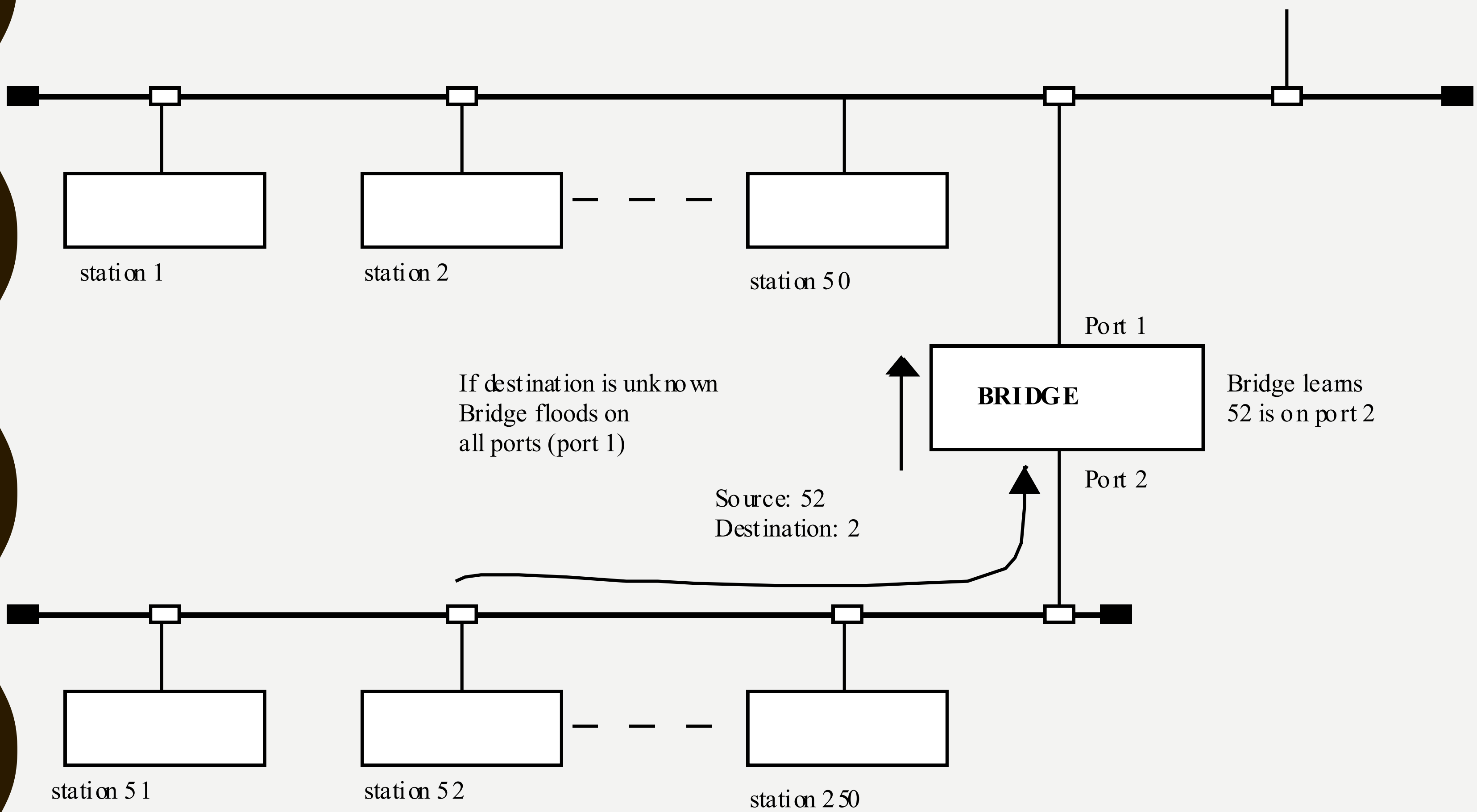
TRANSPARENT BRIDGES/SWITCHES

frame forwarding:

- Frames which arrive are handled in one of 3 different ways:
- Same LAN. If destination address on same LAN as source address then discard packet.
- Different LAN. If destination address on different LAN to source address then forward packet.
- Unknown destination. If location of destination address is not known then ‘flood’.
- Broadcast Address. ‘flood’.

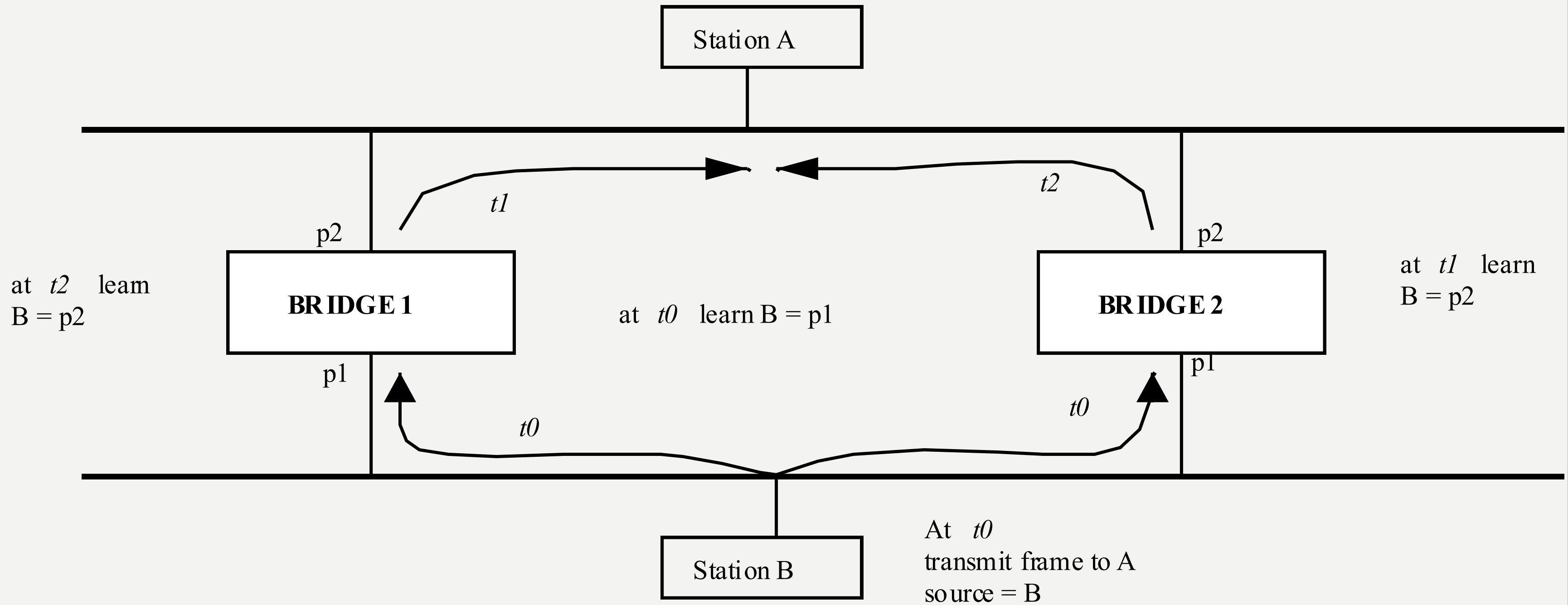
ADDRESS LEARNING:

Bridges/switches update their forwarding database when a frame arrives on a particular port, since they know that the originating address must be on the port that the packet arrived on.



BRIDGE / SWITCH CYCLES

- The address learning works well if there are no alternative routes in the internetwork connections. i.e. a tree structure.
- However there often are and then bridges/switches might cause loops.



Bridges/switches cannot now forward to station B

BRIDGE/SWITCH CYCLES - SOLUTION

- Need protocol to avoid the problem.
- Result from graph theory states: For any connected graph (nodes and edges connecting pairs of nodes) there is a *spanning tree* of edges which maintains the connectivity but contains no closed loops.
- Each LAN represents a graph node and each bridge/switch corresponds to an edge.

SPANNING TREE - ALGORITHM

- Bridges/Switches have numbers.
- Broadcast number every few seconds.
- One bridge/switch becomes the *root bridge.*
- Bridges/switches discover route to *root* via the *root port*.
- Routes might have costs.
- A *designated bridge* is determined for each LAN - minimum cost path to the root bridge.
- Only designated bridge/switch can forward to and from its LAN.
- Bridges/switches communicate with a Bridge Protocol Data Unit (BPDU) consisting of:
  - the originating bridge/switch number
  - the number of the bridge/switch thought to be the root
  - the path cost to the root

SPANNING TREE - EXAMPLE

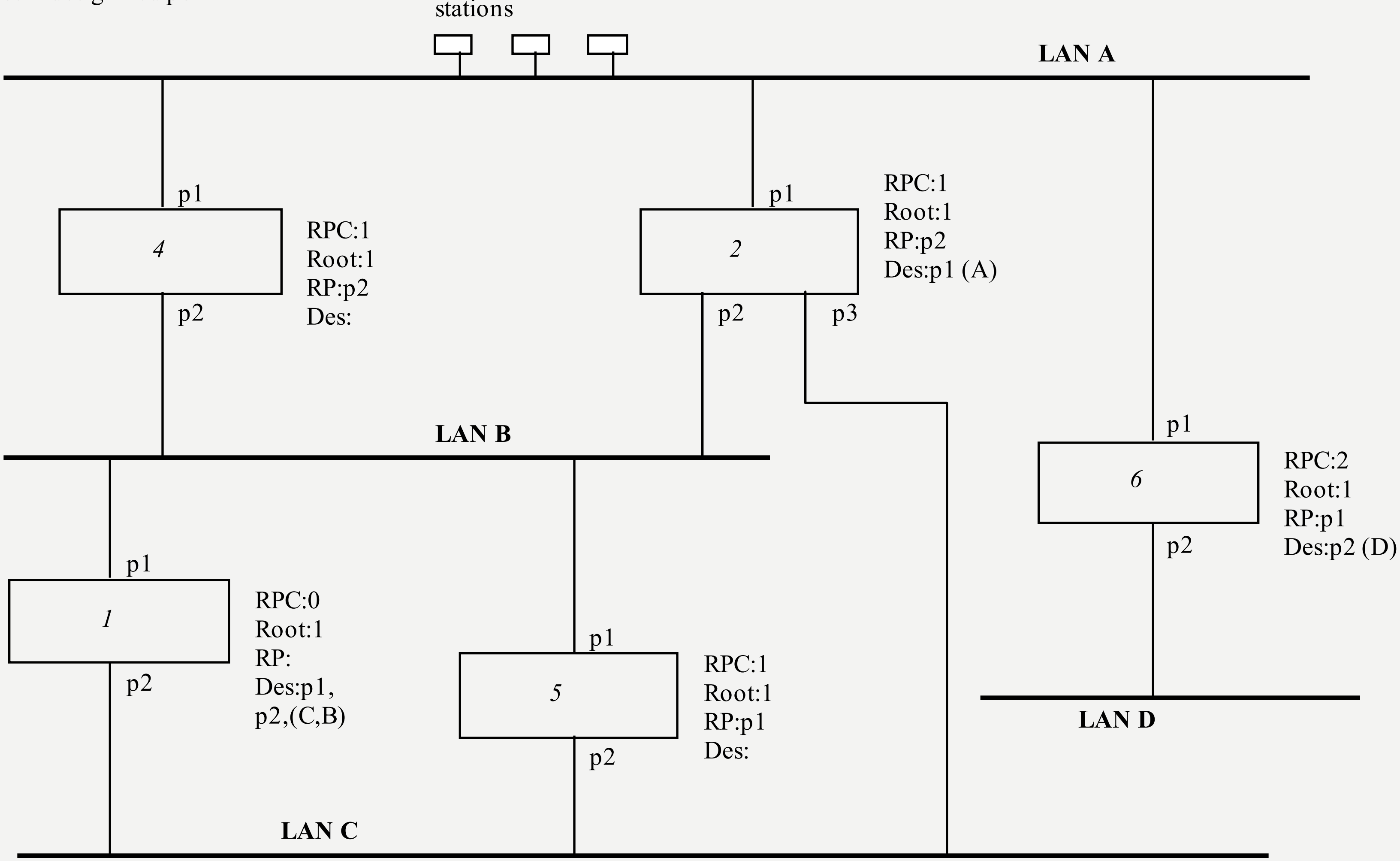
- Initially every bridge/switch thinks it is the root - and it broadcasts a BPDU to assert this fact.
- If a bridge/switch gets a BPDU indicating a ‘superior’ bridge exists it assigns its *root port* and path cost to root.
- If a bridge/switch gets a BPDU from a bridge with a shorter *root path* it releases any claim to be the *designated* bridge for the segment.

- Hence the lowest numbered bridge/switch becomes the root.
- Each LAN segment has one *designated* bridge/switch

Bridge/switch ports which are not root or designated ports are blocked.

SPANNING TREE - EXAMPLE

RPC = root path cost
Root = believed root bridge
RP = Root port
Des = designated port



LOCAL AND REMOTE BRIDGES

- **Local Bridges/Switches** - Connect two (or more) adjacent LANs. Throughput likely to be high. Hosts not likely to notice much performance degradation unless waiting for each packet to be acknowledged.

- **Remote bridges** - Connect two (or more) LANs which are widely separated. Bridge consists of two ‘half bridges’ connected by a WAN type link. Link typically 64Kbps or 2Mbps.

MANAGED BRIDGES/SWITCHES

- Bridges/Switches often available in a *managed* form.
- Bridges/Switches managed from a management station.
- Bridges/Switches can be loaded with forwarding tables.
- Bridges/Switches might only forward some types of packets.
- Bridges/Switches might only forward for specific source hosts.

MANAGED BRIDGES/SWITCHES

- Managed bridges/switches often provide feedback
  - Traffic Load Reports. Loads on attached networks and proportions forwarded.
  - Forwarding Problems. Problems experienced in the form of delays when trying to forward data.
  - Network Errors and their types.

- Bridge to management station protocols required.
  - Need agreed description of data objects.
  - Need agreed value ranges for data types.
  - Need to cope with multi manufacturer products.